METALLIC CAP CLOSURE HAVING WATER REPELLING PROPERTIES AND METHOD OF FABRICATING THE SAME

BACKGROUND OF THE INVENTION

(1) Field of the Invention

[0001] The present invention relates to closures or caps used in containers designed to store and transport liquids in general and, more specifically, to a non-wetting metallic cap having water repelling characteristics. Hereinafter, the terms "closure," "cap," "crown cap," "top," or "crown top," are used interchangeably as synonymous terms.

(2) Background of the Art

[0002] Bottles of many different shapes, sizes, and materials have been widely used for containing and transporting different types of liquids, including those for human consumption, such as, beer, soft drinks, water, juices, coolers, and milk, as well as liquids used for other purposes such as cleaners, raw materials used in different industrial processes, and the like. In many of these applications, a metallic cap, or top, is provided for adequately sealing the contents of the bottle in order to prevent leakage to the outside as well as contamination by outside seepage of foreign substances. Because of the metallic nature of these caps and the extensive exposure to water and moisture during the manufacturing process as well as the transport and storage of these containers, there continues to exist a cap oxidation problem caused by the corrosive environment created by the water or moisture transported by capillary effects and/or trapped in confined areas between the cap and the container, such as, for example, locations between the cap skirt and the bottle rim or neck.

[0003] Usually, during the manufacturing process of a metallic cap, different layers of ink are first deposited on one surface of a metal plate in order to create logos and promotional messages followed by application of a clear protective varnish coating and subsequent curing in a continuous oven. Printing can also be done on the other side of the metallic surface for promotional campaigns or games. Cap shells are then produced

in a punching process, after which, liners are applied to the interior of the shells before they can be applied to close the bottles.

[0004] Unfortunately, the rust that eventually appears on the edge of the crowns once they are crimped on the bottles moves upwardly to the interior zone between the surface of the crown skirt and the exterior surface of the bottle finish. This rust-migration process is facilitated by the presence of water in that confined space; water that has either been trapped therein during the bottling process or transported thereto by a capillarity effect induced by the small clearances between the cap and the bottle neck and the wetting characteristics of conventional caps.

[0005] It is important to highlight that any water that penetrates in those spaces between the interior surface of the skirt of the crown and the exterior of the bottle finish could eventually damage the cap's inner surface spite of the fact that a protective layer has been applied thereto. This is so because of pin holes or scratches generated during the bottling operation or the different handling processes before the bottling operation. The problem of rusting metallic caps is undesirable for at least cosmetic reasons. Cosmetically, customers will certainly question the quality of the product when opening a bottle that contains rings of rust around its neck. Therefore, even thought bottling companies have implemented procedures attempting to prevent corrosion in the edges of the crowns once they are applied to the bottles with product, the presence of rust is unavoidable, thus affecting the shelf life of the product and potentially causing a customer to become dissatisfied with the product.

[0006] As part of standard manufacturing processes, metallic caps are protected with protective layers on both exterior and interior surfaces. In addition, steel sheets used in the crown cap industry are externally covered with a layer of tin or chromium intended to protect the external surfaces against oxidation and also to effect other desired surface properties. However, because this layer of tin or chromium applied after the metal has been rolled is only superficial, it is not part of the base alloy and thus unable to provide the desired rust protection to the edges of the cap created by cutting the original steel sheets. Also, the thin surface layer of tin or chromium as well other protective layers

may be removed or scratched during the cap manufacturing or bottling processes, thus creating several potential sites for subsequent rust development.

[0007] There are many reasons why one would prefer a metallic cap over one made of plastic. The fabrication of plastic caps usually involves expensive and complicated injection molding machinery. There are also special bottle neck construction requirements for applications using plastic caps. In addition, because of the injection molding fabrication process, plastic caps are much more difficult to imprint with the brand or producer logos, promotional messages, and the like, besides the fact that the imprint finish achieved with metallic surfaces is much more attractive. Also, consumer preference may dictate the use of a metallic crown cap, particular when dealing with traditional drinks and premium presentations, such as, for example, beer.

[0008] Because crown caps of different types, sizes, shapes, and corrugation designs will continue to exist, a need exists for a new metallic cap that will maintain the known functionality afforded by metallic caps, such as the ability to print logos and promotional messages thereon, and, at the same time, eliminate, or at least significantly reduce, the existing corrosion problem caused by water or moisture transported by capillary effects and/or trapped in confined areas between the cap and the container.

BRIEF SUMMARY OF THE INVENTION

[0009] The present invention relates to a water repelling, or non-wetting, metallic closure for liquid containers and methods of fabricating the same, such metallic closures being capable of, among other advantages, eliminating the current corrosion problem in confined areas between the cap and the container.

[0010] A water repelling cap in accordance with a feature of the invention comprises: a closure shell, and a non-wetting material layer deposited over at least a portion of an inside surface of the shell. In accordance with another feature of the instant invention, a water repelling cap for a container having an opening with a rim comprises a closure cap and moisture repelling means for repelling moisture from confined regions between an inside surface of the cap and an outside surface of the container.

[0011] A method for manufacturing a water repelling cap in accordance with another feature of the invention comprises: providing a metallic sheet, applying a non-wetting material layer to a surface of the sheet, and forming the cap from the metallic sheet. The method may also additionally comprise applying and curing a coat of varnish, imprinting the metallic sheet with at least one of a brand name, a producer logo, and a promotional message, and curing ink before applying the non-wetting material layer. In accordance with yet another feature of the invention, a method for manufacturing a water repelling cap comprises: providing a metallic sheet, forming at least one cap from the metallic sheet, and applying a non-wetting material layer to at least a portion of an inner surface of the cap. In accordance with yet another feature of the invention, a method for manufacturing a water repelling cap comprises providing a roll-on metallic cap, and applying a non-wetting material layer to at least a portion of an inner surface of the cap.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0012] In order to facilitate the understanding of the present invention, the description of the invention disclosed herein will be provided with reference to the specific embodiments illustrated in the appended drawings or figures, wherein like structures are identified with like reference designations. The invention will be described and explained with additional specificity and detail by the use of the accompanying drawings, wherein:

FIG. 1 illustrates a side view of a crown cap comprising a first embodiment of the present invention; and

FIG. 2 illustrates a side view of a roll-on cap comprising a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0013] FIG. 1 illustrates a first embodiment of a metallic crown cap, or top, 10 having water repelling characteristics, the crown cap 10 comprising a metallic element 11 having a top portion 12, an under portion 14, and a corrugated skirt 16 with a plurality of skirt corrugations 18. Before labels and/or text is imprinted on the cap, a layer of a non-wetting primer material 22 is applied to the interior surface 14 of the metallic element 11, on top of which a subsequent liner 24 may also be applied. The general process after imprinting brand names or other indicia is to form the cap shell in punching presses. Then the liner, whatever its composition might be, is applied to the interior of the crown shell. In some cases a cure operation is necessary to get the correct adhesion of the liner to the crown shell. Although a crown cap having a liner has been illustrated, the present invention is equally applicable to a linerless crown cap.

[0014] In use, the metallic crown cap 10 is installed with its under portion 14 on the upper surface of a glass or plastic bottle neck rim (not shown) with the liner 24 firmly kept against the neck rim, preventing leakage of the liquid content as well as other gases, including carbon dioxide used for carbonation. For caps containing a liner, the liner 24 is typically made of different materials such as cork, rubber, latex, PVC, and non-PVC compounds. Once consumption is desired, the metallic crown cap 10 is simply pried off with an opener. Other crown caps are designed to allow their removal by twisting the crown cap off the bottle.

[0015] Preferably, the metallic material for the cap includes, for example, tin-free steel, electrolytic-tin plate, and aluminum; although the manufacturing process is different for aluminum caps. Before punching the metallic element 11 in the shape of a crown cap, one or several layers of printing ink (not shown) are deposited on the upper surface 12 in order to differentiate one crown design from another mainly with the logo of the beverage producer, the logo of the beverage brand, or promotional messages. In order to increase production, it is normal to start the manufacturing process with a metal sheet from which a large amount of caps is made. The application of the ink layers is typically made through one or several lithographic processes such as offset, etc. Once applied, the ink imprints are cured in a continuous oven, or furnace, at temperatures

ranging from about 150 to about 180 °C, and more preferably between about 160 and about 165 °C. The residence time of the metallic sheets in the curing oven is varied between about 7 and about 15 minutes, and more preferably between about 8 and about 9 minutes. It is also possible to imprint these labels and logos, or any other promotional messages, on the under portion 14 of the linerless crown cap 30.

[0016] A clear protective varnish coating (not shown) may also be applied over the ink imprints of the top surface to prevent scratches and damages of that surface and also to allow the mobility of the crown in the chutes of the bottling lines. Preferred examples of methods to apply this protective varnish coating include: lithography applied to flat metal sheets using application rollers, electro deposition (coil coating), or spray application technology. Once applied, the protective coating may also be cured in a continuous oven at a temperatures ranging from approximately 160 to 210 °C, and more preferably between about 177 and about 183 °C. The residence time of the imprinted metal sheets in the curing oven to cure the protective varnish coating may vary from about 7 to about 15 minutes, and more preferably between about 8 and about 9 minutes. In addition, depending on the materials used for coating or imprinting the crown cap 10, an Ultra Violet (UV) light source may also be used for curing purposes.

[0017] Subsequently, a protective layer of a primer material 22 may also be applied to the under portion 14 of the linerless crown cap 10. One of the main purposes of the primer layer is to enhance adhesion to the interior surface of the cap for any kind of liner or subsequent layers deposited thereon. Of course it also helps in providing corrosion resistance to steel caps. Primer materials also enhance adhesion to the cap of other materials (mainly inks) applied in the subsequent steps. The nature of the primers depends on the material to be adhered thereto, e.g., for PVC-based materials, the primers are vinyl type, and for non pvc materials, the primers may be polyesters, epoxies, or alquidalic. Once applied, the primer layer 22 may also be cured in a continuous oven at a temperatures ranging from about 160 to about 210 °C, and more preferably between about 197 and about 203 °C. This curing time may vary from about 7 to approximately 15 minutes, and more preferably between about 8 and about 9 minutes.

[0018] The inventor has discovered that it is possible to control the capillarity in the confined regions between the container and the crown cap 10 by the addition of additives to the composition of the primer layer 22. Capillarity, or capillary action, is a phenomenon in which the surface of a liquid is observed to be elevated or depressed where it comes into contact with a solid. Capillarity is a result of the combined effect of adhesion, the attractive (or repulsive) force between the molecules of the liquid and those of the solid surface, and cohesion, the attractive force between the molecules of the liquid. The relative magnitudes of the adhesion and cohesion forces determine the shape of a liquid surface in contact with a solid surface and other fluids (usually air). Specific liquid-solid combinations are classified as wetting or non-wetting, depending on the contact angle between the liquid and solid surfaces. If the contact angle is greater than 90°, the liquid is wetting; if it is less then 90°, the liquid is non-wetting. Wetting behavior is determined by the particular liquid-solid combination. In known primer materials, a wetting interface exists between the crown cap and the bottle surface covered by the cap, leading to the accumulation of water and moisture in the confined spaces there between due to capillary action.

[0019] Based on the physical principle just explained, a drop of water forms a contact angle of approximately 15° against a glass surface. For this reason water in a container forms a concave shape in a small diameter glass pipe placed therein and, as a result, the liquid level in the pipe rises until certain height above the water level in the container. There are materials that because of their very low surface tension form with water relatively high contact angles. One such material is Teflon, whose contact angle is around 112°. Thus, if a small diameter Teflon pipe is introduced into a container with water, the liquid surface inside of the pipe will assume a convex shape and, as a consequence, the water level in the Teflon pipe will drop below the water level in the container instead of rising. The present invention uses this principle to get a crown whose internal surface, once mounted on the bottle, remains dry by preventing the upward flow of water by capillary effect to the confined region between the cap and the bottle. The way of getting the repellant properties of the crown is to add in correct dozes the repellant substance to the primer coating to be applied on the interior surface of the crown caps.

[0020] In order to create a non-wetting interface between the crown cap 10 and the bottle neck surface, the choice of additive to be added to the primer composition depends on the material used for the primer layer 22. For example, for a PVC-based primer, including, but not limited to, polyesters, poliketones, epoxies, phenolics, and poliacrilics, the material of choice is Zonyl, wherein the Zonyl concentration in the primer layer 22 composition has a dry weight ratio ranging from approximately 1 to approximately 10%, and is preferably about 4%. For a PVC-free lacquer primer, including, for example, but not limited to, polyesters and epoxy-phenolic resins, the material of choice can be Teflon. In this case, the Teflon concentration in the primer composition has a dry weight ratio ranging from approximately 1 to approximately 10 %, and is preferably about 7 %. Those of ordinary skill in the art will appreciate that the instant invention is applicable to different types of caps, including crown caps and roll-on caps. In addition, it is also possible to apply a layer of non-wetting material to only a portion of the inner surface of the cap, including the surface between the edge of the cap and a region of the inner surface in sealing contact with the opening of the container.

[0021] As will be understood by those of ordinary skill in the art, some of the advantages of this invention include, for example, the elimination, or at least the significant reduction, of oxidation of the undersurface of the crown cap 10 once applied to the container, thus increasing the shelf life of the container and improving product appeal to customers.

[0022] The present invention is also applicable to roll-on caps. FIG. 2 illustrates a side view of a roll-on cap 40, comprising a metallic element 41 having a top portion 12, an under portion 14, and inwardly projection cap threads 42. Similar to the illustration of FIG. 1, the roll-on cap 40 may also have a layer of a non-wetting primer material 22 applied to the interior surface 14 of the metallic element 41, on top of which a subsequent liner 24 is also applied. Similar to the disposition of layers in FIG. 1, a clear protective varnish coating (not shown) may also be applied to the under portion 14 of the roll-on cap 40. The same materials for the different layers, compositions, temperature ranges, and residence curing times disclosed for the crown cap 10 are applicable to the roll-on cap 40. In both embodiments, it is also possible to apply the primer material layer 22 only to a fraction of the under portion 14 of the caps, including

the surface between the edge of the cap and a region of the inner surface in sealing contact with the opening of the container.

[0023] The method of manufacturing non-wetting caps or closures is also within the scope of the present invention. In this regard, the details presented hereinabove in conjunction with the apparatus disclosure, including materials, compositions, manufacturing conditions, etc, are also applicable to the method of manufacturer and will not be repeated. Initially, metallic sheets, preferably tin-free steel or electrolytic-tin plate, are provided with at least one overcoat of varnish applied thereto and properly cured. A protective layer of a non-wetting primer is then applied to facilitate movement of the caps throughout the manufacturing process. Once the primer coating and varnish are completed and cured, conventional or transfer inks are applied over the varnish and cured. Once the application of the different layers of materials is finished, the metal sheets are then punched to form closure shells in order to manufacture the water-repelling crown caps. It is also possible to first punch the crown shells from the metallic plate before the application of the different layers of materials.

[0024] Although typical embodiments and details have been explained herein above with the intention of illustrating several best modes of the present invention as applied to crown or roll-on caps having water repelling properties, and the like, it is understood that several changes and variations in the methods, apparatuses, and systems disclosed herein may be implemented within the scope of the present invention. The scope of the invention being appropriately determined by the claims appended below.